Method for Producing a Double-Chamber Hollow Profile

[0001] This application is a national phase application of International application PCT/EP2004/011635 filed October 15, 2004 and claims the priority of German application No. 103 57 139.3, filed November 3, 2003, the disclosure of which are expressly incorporated by reference herein.

[0002] BACKGROUND AND SUMMARY OF THE INVENTION

[0003] The invention relates to a method for producing a double-chamber hollow profile ~~according to the preamble of claim 1~~with integrally-joined chamber walls.

[0004] A method of the generic type is disclosed by DE 199 09 924 C2. This sets forth a method for the internal high pressure forming of a hollow profile in a forming tool, in which the hollow profile is produced in the form of a double-chamber hollow profile. An extruded profile, the tubular hollow spaces of which, running parallel to one another and divided from one another by a dividing wall, form the chambers, is used as double-chamber hollow profile. The walls enclosing the chambers and the intermediate dividing wall are connected together by a cohesive material joint, that is to say they are integrally joined. The extruded profile formed in this way is inserted into an internal high pressure forming tool, following which a high internal pressure is exerted in both

chambers, serving to expand the walls of the double-chamber hollow profile. The expansion is maintained until the walls come to bear on the recess cavity of the forming tool. During the expansion, however, the dividing wall forms a type of tensile anchor on the adjoining walls with the result that sunken points occur in this area of the expanded double-chamber hollow profile. At the same time the dividing wall becomes elongated, reducing its wall thickness. Depending on the expansion capacity of the hollow profile material and the degree of deformation to be achieved in the expansion process, tears can occur in the dividing wall and in those areas in which the walls of the chambers directly adjoin the dividing wall. Since this generally occurs during the expansion process, it is not possible to obtain the desired contour and the desired cross section of the double-chamber hollow profile to be formed, so that the partially formed hollow profile has to be scrapped as a reject part.

[0005] The object of the invention is to develop a method of the generic type so as to provide a relatively simple way of reliably producing a double-chamber hollow profile.

[0006] According to the invention the object is achieved by ~~the features of claim 1~~ a method for producing a double-chamber hollow profile with chamber walls being integrally joined to one another, in which a tubular hollow profile blank having a single hollow space is

bent to form two branches which run essentially parallel to one another, and the bent blank is inserted into a internal high pressure forming tool and expanded into a final shape of the hollow profile by a high internal fluid pressure. The high pressure is applied until the opposing walls of the branches bear against one another and the remaining walls bear against the recess cavity of the forming tool.

[0007] The fact that the double-chamber hollow profile is produced by bending a single tubular hollow profile blank ~~and~~ permits costly extrusion dies ~~can thereby~~ to be dispensed with, and makes the method according to the invention particularly easy to perform. The expansion can also be reliably performed without any problems by means of a high internal fluid pressure, since the dividing wall is not composed in the usual way of one wall layer but in an entirely new departure of two wall layers resulting from the bending operation. The dividing wall thereby no longer functions as a tensile anchor, which might counteract the capacity of the hollow profile for expansion. The hollow profile blank can therefore be expanded without sustaining damage until its walls bear fully against the recess cavity of the forming tool. In this way higher degrees of deformation can also be achieved. Since the one end of the double-chamber hollow profile is closed by virtue of the bending section, the sealing of the hollow profile during the internal high pressure forming process is substantially facilitated because only the

open end of the hollow profile has to be sealed, thereby at the same time reducing the cost of the apparatus for the internal high pressure forming process. The closed end readily affords increased corrosion protection for the hollow profile, since at this end, at least, no moisture can get into the hollow profile. When assembling with other parts the finish- formed hollow profile can thereby advantageously be used with the closed end specifically at points of the assembly exposed to moisture. The method according to the invention may be used, for example, in producing a frame or member in motor vehicle construction.

[0008] In a preferred development of the inventive method, ~~according to claim 2~~ the hollow profile blank is bent about a transverse axis to its longitudinal extent. The bending of the blank about the transverse axis constitutes an especially easy and reliable variant of the invention, in which the two branches come to rest on one another.

[0009] In another preferred development of the invention, ~~according to claim 3~~ an elongate body is in the bending process enveloped by the two branches of the hollow profile blank. This body may advantageously serve simultaneously as bending mandrel and as attachment, which in enveloping may be joined merely as a result of the bending operation to the double-chamber hollow profile, forming a press fit. This press fit can also be achieved due to the action of the high internal fluid pressure during the operation to expand the double-chamber hollow profile. In

assembling components by the development of the method according to the invention, therefore, separate costly joining operations such as welding etc. can be dispensed with. Alternatively the body may also be enveloped by the branches of the hollow profile blank, so that the body can be drawn out from the enclosure of the two branches before or after the internal high pressure forming. The eye thereby produced on the double-chamber hollow profile can then be useful in a variety of ways. For example, the eye may serve as suspension loop or be used as a simple lead-though bushing for attachments, cables or media-carrying pipes. The body may be composed of solid material in the nature of a bar or may take the form of a peripherally enclosed hollow profile. In the case of a hollow profile this may be filled with a liquid or solid medium during the bending operation and the internal high pressure forming operation in order to prevent it being crushed.

[0010] In another especially preferred development of the invention, ~~according to claim 4~~ the hollow profile blank is bent by one end about an axis at 45° to its longitudinal extent and is bent back by the other end about an axis mirror symmetrical with the former axis, the opposing walls of the branches of the hollow profile blank thereby produced running along the central transverse axis of the blank. The resultant double bending of the hollow profile blank creates a double-chamber hollow profile, the branches of which do not come to rest on one another

but side by side with one another. The very flat form of the closed end of the double-chamber hollow profile produced by virtue of this process means that this end can serve as a support or console, or if the flat section is perforated as a seat.

[0011] In another preferred development of the invention, ~~according to claim 5~~ the hollow profile blank is filled with a liquid or solid medium prior to the bending operation. This serves largely to prevent wrinkles or folds occurring during the bending operation. The solid medium, at least, is then dissolved out of the hollow profile blank after the bending operation. The liquid medium for the further internal high pressure forming operation may appropriately be used as pressure fluid, so that in this operation a renewed filling of the hollow profile blank can be dispensed with, saving time and reducing the cost of the apparatus for this purpose.

[0012] In another preferred further development of the invention, ~~according to claim 6~~ the two opposing walls of the two branches are coated with an adhesive or a solder prior to the internal high pressure forming. The coating with adhesive or a solder allows the two branches to be immovably joined to one another by ~~means of~~ heat treatment after the internal high pressure forming. In the case of an adhesive coating it is also feasible for this to be activated even during the bending

operation, so that the adhesive bonding already occurs when the two branches are brought to bear against one another.

[0013] In another especially preferred development of the invention at least one of the two branches is impressed on the wall opposed to the other branch, forming one or more interlocking elements. At a corresponding point opposite these, mating interlocking elements are formed on the opposing wall of the other branch. By impressing the interlocking elements and forming the mating interlocking elements, which are located so that they lie precisely opposite one another, a positively interlocking connection is created between the two branches of the hollow profile, in that the interlocking elements intermesh in the mating interlocking elements or vice-versa following the bending operation, in particular after the internal high pressure forming operation. This serves to prevent the branches shearing laterally out of one another under mechanical stresses. In forming the mating interlocking elements it is advantageous to undertake this through internal high pressure forming simultaneously with the expansion of the hollow profile blank, these elements being formed out of the wall into the interlocking elements. For economical forming of the mating interlocking elements, the internal high pressure forming process is therefore used for two different purposes. It is also equally feasible, however, to stamp the mating interlocking elements out in any

production phase of the double-chamber hollow profile. In order to ensure firm holding of the two branches of the hollow profile blank against one another in any direction, it is advantageous to design the interlocking elements and the mating interlocking elements so that both types of elements have undercuts. This then allows the mating interlocking elements to be latched into the interlocking elements under a more or less light mechanical pressure.

[0014] In another preferred development of the invention, ~~according to claim 8~~ the two branches are preferably perforated on the walls remote from one another during the internal high pressure forming. The opposing walls of the two branches are then clinched by means of a male die fed through the respective hole and a female die likewise fed through the respective hole on the other branch. The clinching means that the two branches are likewise firmly anchored to one another. This joining method may follow the internal high pressure forming operation with a high internal pressure persisting inside the internal high pressure forming tool, the high backing pressure prevailing ensuring that no sunken points occur in the area of the punched holes. The perforation and clinching of the double-chamber hollow profile can also be undertaken in a subsequent operation outside the internal high pressure forming tool.

[0015] ~~The invention is explained in more detail below with reference to a number of exemplary embodiments represented in the drawings, in which:~~Other objects, advantages and novel features of the present invention will become apparent from the following detailed description of the invention when considered in conjunction with the accompanying drawings for example.

BRIEF DESCRIPTION OF THE DRAWINGS

[0016] Fig. 1 shows a side view of a tubular hollow profile blank for producing a double-chamber hollow profile in accordance with an embodiment of the invention,

[0017] Fig. 2 shows a perspective side view of hollow profile blank in Fig. 1 following a bending operation about a transverse axis to the longitudinal extent of the hollow profile blank,

[0018] Fig. 3 shows a perspective side view of a double-chamber hollow profile ready formed by a method according to an embodiment of the invention, with perforated and clinched branches,

[0019] Fig. 4 shows a perspective side view of a detail of the open end of a double-chamber hollow profile finish-formed by a method according to an embodiment of the invention, with interlocking element impressed in one of the branches and mating interlocking element formed in the other branch,

[0020] Fig. 5 shows a perspective side view of a detail of a double-chamber hollow profile produced according to an embodiment of the invention with envelopment of an elongate body,

[0021] Fig. 6 shows a perspective view of the hollow profile blank in Fig. 1 with one end bent about an axis at 45° to its longitudinal extent,

[0022] Fig. 7 shows a top view of the hollow profile blank in Fig. 6, the other end of which is bent back about an axis mirror symmetrical with the 45° axis.

[0023] Fig. 8 shows a perspective view of a double-chamber hollow profile finish-formed by a method according to an embodiment of the invention, with a bend of the hollow profile blank in Fig. 6 and Fig. 7.

DETAILED DESCRIPTION

[0024] Fig. 1 shows a tubular, hollow cylindrical hollow profile blank 1, which runs rectilinearly and serves as the initial basis for the production of a double-chamber hollow profile 2. The hollow profile blank 1 provided with a circular cylindrical cross-section has a single hollow space 3 in its interior. The double-chamber hollow profile 2 is now produced by bending the hollow profile blank 1 back about a transverse axis 4 to the longitudinal extent thereof, in accordance with Fig. 2, to form two branches 5 and 6, until these run at least virtually parallel to one another, that is to say one end 7 of the hollow profile

blank 1 has been bent back by almost 180°. Prior to the bending operation the hollow profile blank 1 has been provided at the points with a layer 8 of an adhesive or a solder, which after bending will be present on opposing walls 9 and 10 of the branches 5 and 6. The bent hollow profile blank 1 is now inserted into an internal high pressure forming tool, which is then closed. On closing of the internal high pressure forming tool the two branches 5 and 6 are pressed against one another, so that by selecting a suitable adhesive, which already develops its adhesion characteristics at room temperature, the two branches 5 and 6 are bonded to one another. The press-fit position of the two branches 5 and 6 means that the bent hollow profile blank 1 will already assume a preliminary shape of the double-chamber hollow profile 2 to be formed. It is also feasible here for the bent hollow profile blank 1 to be compressed during the closing operation, so that the said preliminary shape takes on very approximately the desired rectangular cross section of the two branches 5 and 6 of the double-chamber hollow profile 2.

[0025] The chambers 11 and 12 of the ends 7 and 13 of the branches 5 and 6 are now sealed by means of a suitably shaped axial die, the axial die then generating a high internal fluid pressure which expands the bent hollow profile blank 1 until its walls 14, which also include the walls 15 remote from one another, bear all-round on the recess cavity of

the forming tool. The opposing walls 9 and 10 of the branches 5 and 6 are pressed against one another by the high fluid pressure in such a way that the two branches 5 and 6 can no longer spring back away from one another after the double-chamber hollow profile 2 has been removed from the internal high pressure forming tool, and therefore continue to bear against one another. The pressure fluid transmitting the high internal pressure to the hollow profile blank 1 is relieved on completion of the forming and is led out of the chambers 11 and 12. Finally the internal high pressure forming tool is opened and the finish-formed double-chamber hollow profile 2 is removed from this. The double-chamber hollow profile 2 thus formed can be seen from Fig. 3.

[0026] Alternatively or in addition to the adhesive bonding of the two branches 5 and 6, their walls 9 and 10 may be clinched to one another. To do this it is necessary to punch holes 16 in the walls 15 remote from one another, in order to gain access to the walls 9 and 10 for clinching. In order to prevent sunken points on the walls 15, the perforation and the clinching can be performed whilst the internal high pressure still persists after the expansion of the hollow profile blank 1 in the internal high pressure forming tool. In order to simplify the processing sequence involved in the clinching and the perforation, the one piercing punch may have a female die at its end face, while the opposite piercing punch is so formed at its end face that it is capable of displacing the hollow

profile blank material of the two walls 9 and 10 into the female die of the other punch. In the process the clinching produces knob- or channel-shaped elevations 17, which advantageously by virtue of the process, however, have undercuts, so that the two branches 5 and 6 can be joined together more or less permanently by the positive interlock achieved by the clinching. In addition or alternatively, it is also feasible to impress a channel-shaped interlocking element 18 in at least one of the two branches 5 and 6 – for example in the branch 6. Due to the expansion of the hollow profile blank 1 during the expansion process produced by the high internal pressure the wall 9 of the branch 5 is expanded into the interlocking element 18, forming a mating interlocking element 19 of identical shape. This achieves at least a lateral holding of the branches 5 and 6 against one another, as can be seen from Fig. 4.

[0027] An elongate body 20, here in the form of an elongate tube, may be arranged on the hollow profile blank 1 in the bending operation, which causes the body to be enveloped by the two branches 5 and 6 of the hollow profile blank 1. In the internal high pressure forming process the hollow profile blank 1 with its branches 5 and 6 is deformed to the shape of the body 20, with the result that each branch 5 and 6 acquires a recess 21 of semi-circular cross section. Alternatively it is feasible for the hollow profile blank 1 to be already shaped at a suitable point,

thereby forming the recesses 21, in order to safeguard the body 20 against excessive compression during the bending operation on the hollow profile blank 1. It is also equally feasible for the body 20, during the internal high pressure forming process, to be connected to a separate high pressure circuit, which by means of a pressurized fluid serves to brace the body 20 internally against the externally acting internal high pressure prevailing in the hollow profile blank 1, so that it retains its shape and contour. Furthermore, the hollow profile blank 1 can also be filled, prior to the bending operation, with a liquid or solid medium, so that the blank, after completion of the bending operation, retains its cross sectional shape and contour largely unaltered (Fig. 5).

[0028] Figs. 6 to 8 show a variant of the method according to the invention. Here the hollow profile blank 1 is bent by one end 7 about an axis 22 lying at 45° to its longitudinal extent, producing the branch 23 which protrudes at right angles to the longitudinal axis 24 of the remainder of the hollow profile blank 1. The other end 13 of the hollow profile blank is then bent back about an axis 25 mirror-symmetrical with the axis 22, producing a second branch 26, which comes to lie alongside the branch 23. The opposing walls 27 and 28 of the branches 23 and 26 produced in this case run along the central transverse axis 29 of the hollow profile blank 1 (Fig. 7). After forming by means of the internal high pressure forming technique, the double-chamber hollow

profile 30 with rectangular chamber cross section according to Fig. 8 is obtained. The particular nature of the bending technique, which has much in common with a folding technique, means that the double chamber hollow profile 30 is formed flat and tapering to a point at its closed end 31. As is indicated, moreover, in Fig. 8, the end 31 of the hollow profile 30 is tapered from top to bottom. It should moreover be noted that the joining techniques mentioned in the case of the first exemplary embodiment can be similarly applied to this exemplary embodiment.

[0029] The foregoing disclosure has been set forth merely to illustrate the invention and is not intended to be limiting. Since modifications of the disclosed embodiments incorporating the spirit and substance of the invention may occur to persons skilled in the art, the invention should be construed to include everything within the scope of the appended claims and equivalents thereof.

What is Claimed is:

~~Patent Claims~~